CLAIMS

What is claimed is:

1. A roller cone drill bit comprising:
a plurality of arms;
rotatable cutting structures mounted on respective ones of said arms; and
a plurality of teeth located on each of said cutting structures;
wherein approximately the same axial force is acting on each of said cutting structure.

2. The roller cone drill bit of Claim 1, wherein the axial force on each of said cutting structure is between thirty-one (31) percent and thirty-five (35) percent of the total of the axial force on the bit.

3. A roller cone drill bit comprising:
a plurality of arms;
rotatable cutting structures mounted on respective ones of said arms; and
a plurality of teeth located on each of said cutting structures;
wherein a substantially equal volume of formation is drilled by each said cutting structure.

4. The roller cone drill bit of Claim 3, wherein the volume of formation drilled by each of said cutting structures is between thirty-one (31) percent and thirty-five (35) percent of the total volume drilled by the drill bit.

5. A rotary drilling system, comprising:

a drill string which is connected to conduct drilling fluid from a surface location to a rotary drill bit;

a rotary drive which rotates at least part of said drill string together with said bit

said rotary drill bit comprising

a plurality of arms;

rotatable cutting structures mounted on respective ones of said arms; and

a plurality of teeth located on each of said cutting structures;

wherein approximately the same axial force is acting on each of said cutting structure.

6. A method of designing a roller cone drill bit, comprising the steps of:

(a) calculating the volume of formation cut by each tooth on each cutting structure;

(b) calculating the volume of formation cut by each cutting structure per revolution of the drill bit;

(c) comparing the volume of formation cut by each of said cutting structures with the volume of formation cut by all others of said cutting structures of the bit;

(d) adjusting at least one geometric parameter on the design of at least one cutting structure; and

(e) repeating steps (a) through (d) until substantially the same volume of formation is cut by each of said cutting structures of said bit.

7. The method of Claim 6, wherein the step of calculating the volume of formation cut by each tooth on each cutting structure further comprises the step of using numerical simulation to determine the interval progression of each tooth as it intersects the formation.

8. A method of designing a roller cone drill bit, the steps of comprising:

(a) calculating the axial force acting on each tooth on each cutting structure;

(b) calculating the axial force acting on each cutting structure per revolution of the drill bit;

(c) comparing the axial force acting on each of said cutting structures with the axial force on the other ones of said cutting structures of the bit;

(d) adjusting at least one geometric parameter on the design of at least one cutting structure;

(e) repeating steps (a) through (d) until approximately the same axial force is acting on each cutting structure.

9. The method of Claim 8, wherein the step of calculating the normal force acting on each tooth, on each cutting structure further comprises the step of using numerical simulation to determine the interval progression of each tooth as it intersects the formation.

10. The method of Claim 8, further comprising the steps of:

(a) calculating the volume of formation displaced by the depth of penetration of each tooth;

(b) calculating the volume of formation displaced by the tangential scrapping movement of each tooth;

(c) calculating the volume of formation displaced by the radial scrapping movement of each tooth; and,

(d) calculating the volume of formation displaced by a crater enlargement parameter function.

11. A method of designing a roller cone drill bit, the steps of comprising:

(a) calculating the force balance conditions of a bit;

(b) defining design variables;

(c) determine lower and upper bounds for the design variables;

(d) defining objective functions;

(e) defining constraint functions;

(f) performing an optimization means; and,

(g) evaluating an optimized cutting structure by modeling.

12. A method of using a roller cone drill bit, comprising the step of rotating said roller cone drill bit such that substantially the same volume of formation is cut by each roller cone of said bit.

13. A method of using a roller cone drill bit, comprising the step of rotating said roller cone drill bit such that substantially the same axial force is acting on each roller cone of said bit.